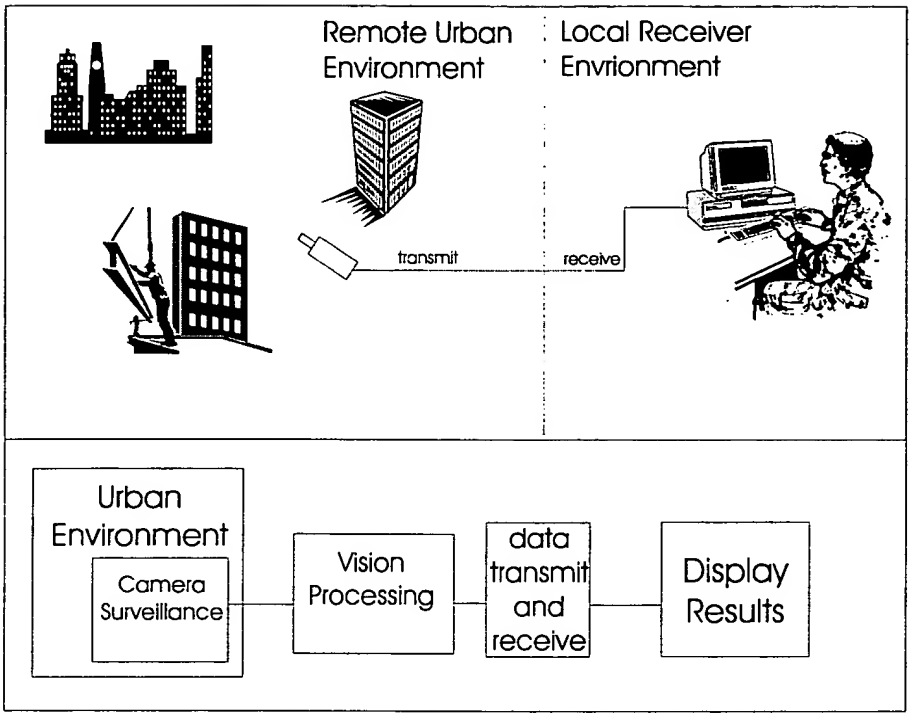


Figure 1: Overview of Potential Behavior Recognition System Use.

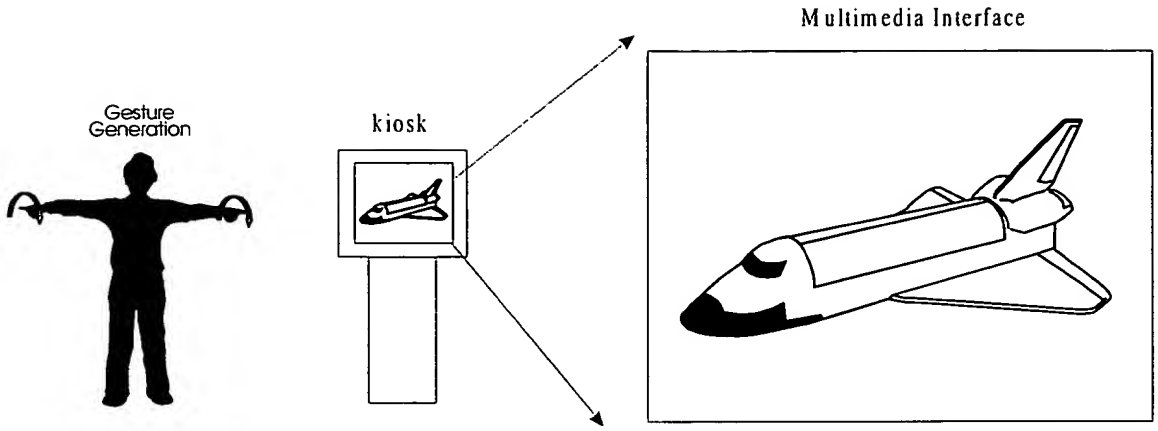


Figure 2: Gesture Recognition System.

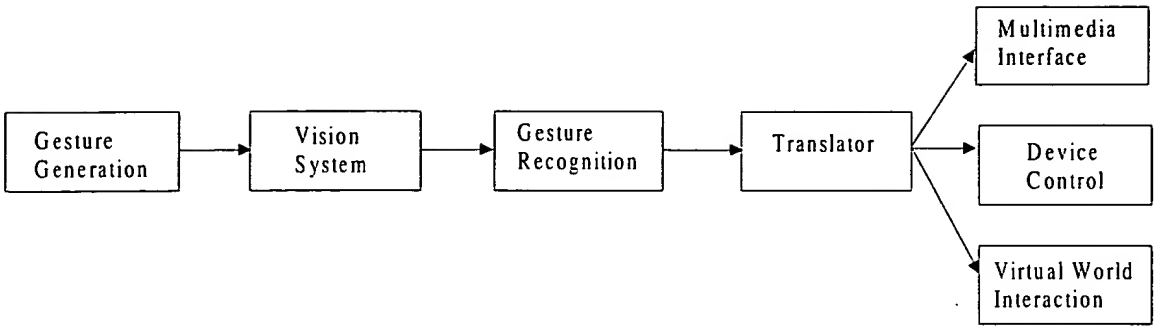


Figure 3: Gesture Recognition System Flow Chart.

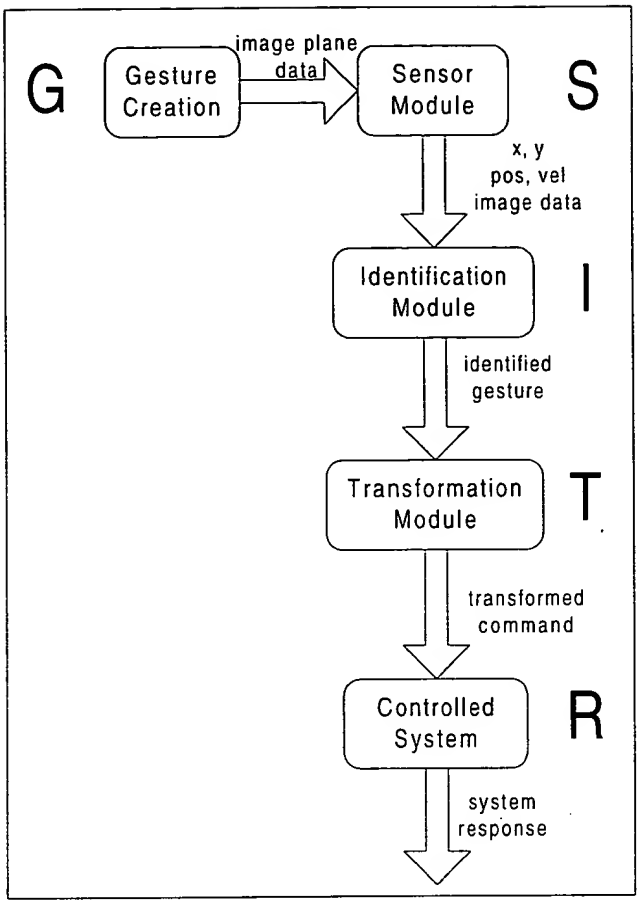


Figure 4: Signal Flow Diagram of the Gesture Recognition System.

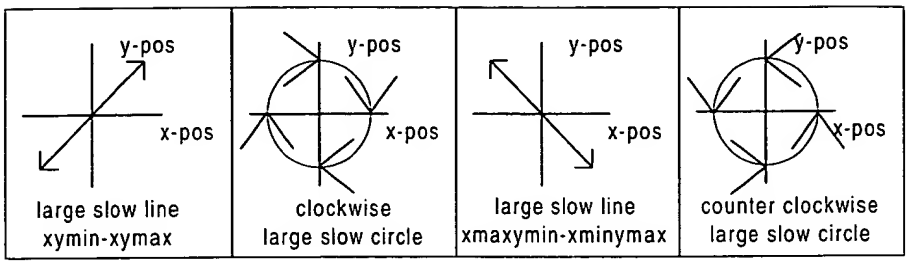


Figure 5: Example gestures, showed in two dimensions.

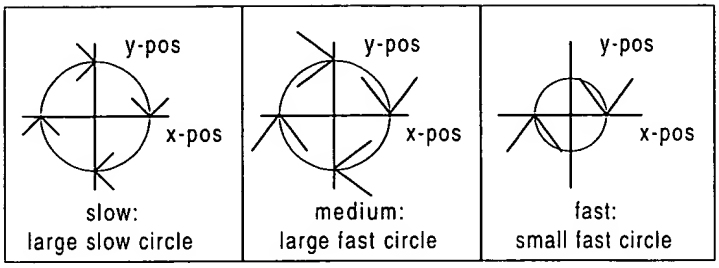


Figure 6: Three Example Gestures.

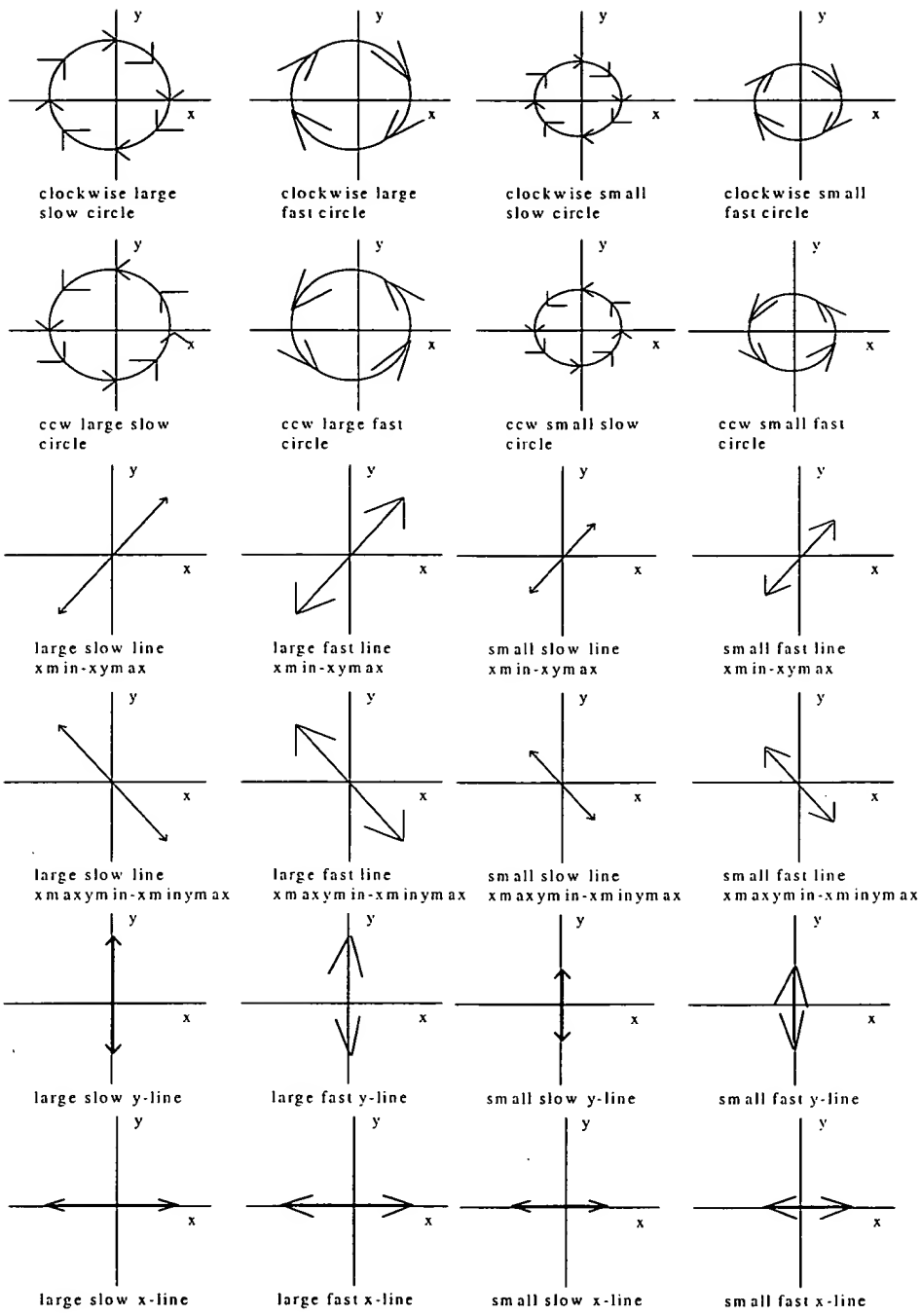
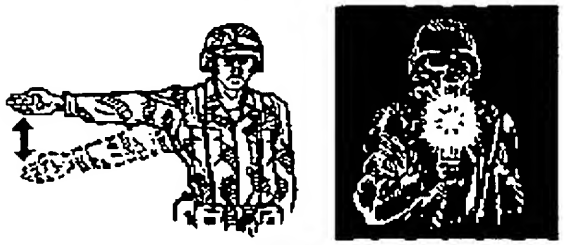


Figure 7: An Example 24 Gesture Lexicon.



DAY

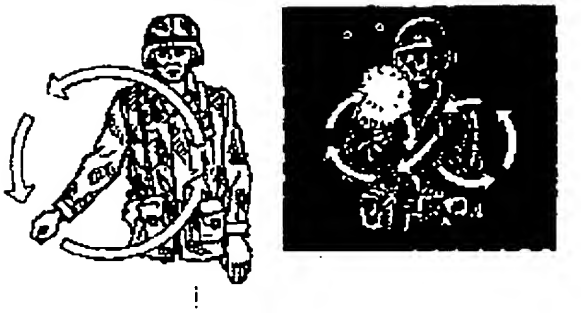
Extend the arm horizontally sideward, palm to the front; wave the arm slightly downward several times, keeping the arm straight. Do not move arm above horizontal

NIGHT

Hold a light at shoulder level; blink it several times toward the vehicle.

Figure 2-12. SLOW DOWN.

Figure 8: Slow Down Gesture.



DAY

Simulate cranking of engines by moving the arm, with the fist, in a circular motion at waist level.

NIGHT

Move a light to describe a horizontal figure 8 in a vertical plane in front of body.

Figure 2-6. START ENGINE, or PREPARE TO MOVE

Figure 9: Prepare to Move Gesture.

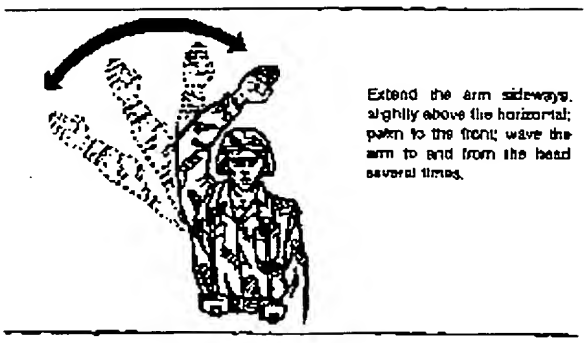
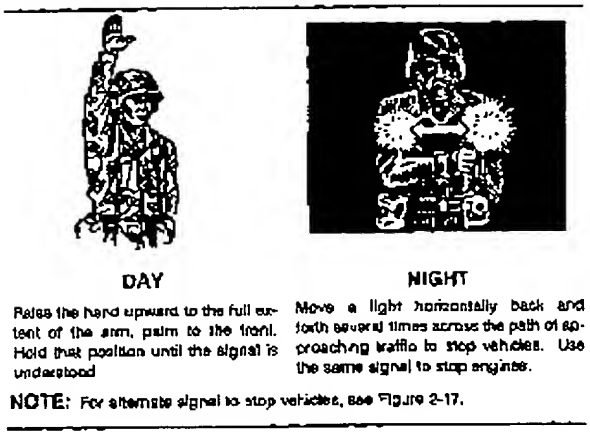


Figure 2-1. ATTENTION.

Figure 10: Attention Gesture.



DAY

Raise the hand upward to the full extent of the arm, palm to the front. Hold that position until the signal is understood

NIGHT

Move a light horizontally back and forth several times across the path of approaching traffic to stop vehicles. Use the same signal to stop engines.

NOTE: For alternate signal to stop vehicles, see Figure 2-17.

Figure 2-7 HALT or STOP.

Figure 11: Stop Gesture.

DAY

Extend the arm horizontally to side, palm outward.

NIGHT

Rotate a light to describe a circle 12 to 18 inches in diameter in the direction of the turn.

Figure 5-12. RIGHT or LEFT TURN.

Figure 12: Right or Left Turn Gestures.

Hold the fist out with thumb up.

Figure 2-22. MESSAGE ACKNOWLEDGED.

Figure 13: "Okay" Gesture.

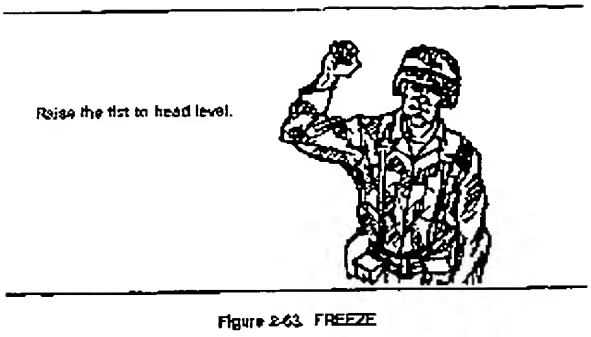


Figure 2-63. FREEZE

Figure 14: Freeze Gesture.

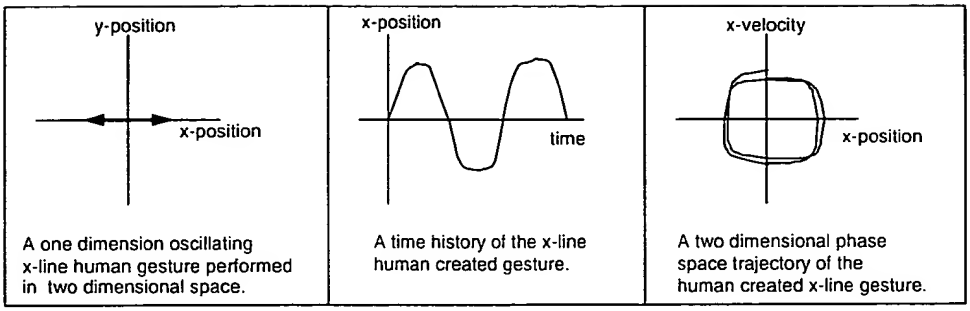


Figure 15: Plots of a Human Created One Dimensional X-Line Oscillating Motion.

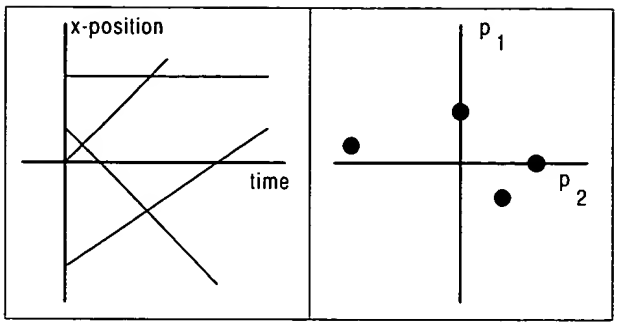


Figure 16: Possible Lines Associated with x(t,p)=p0+p1t and Their Equivalent Representation in the p Parameter Space.

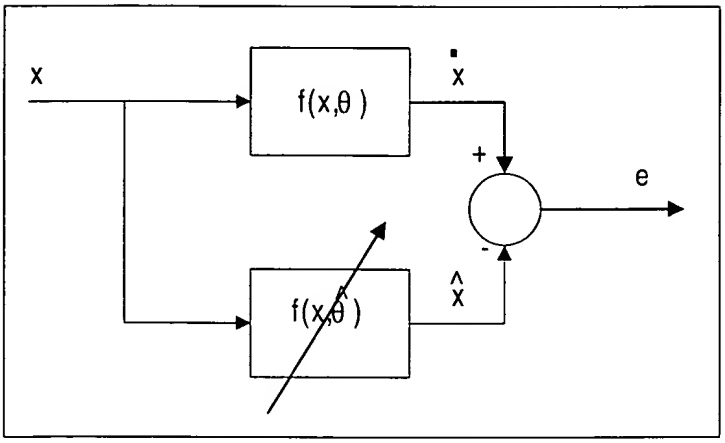


Figure 17: Parameter Fitting: We Require a Rule for q to Bring the Error to Zero.

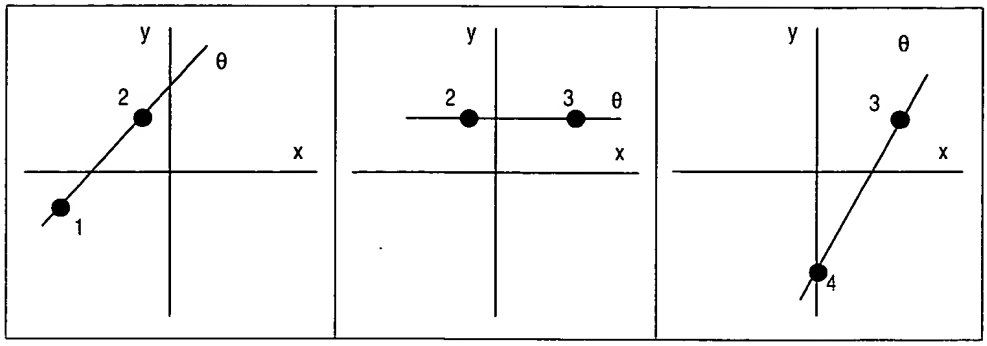


Figure 18: Plots of Different (xi,yi) Data Points that Result in a Different Best Fitting q Line.

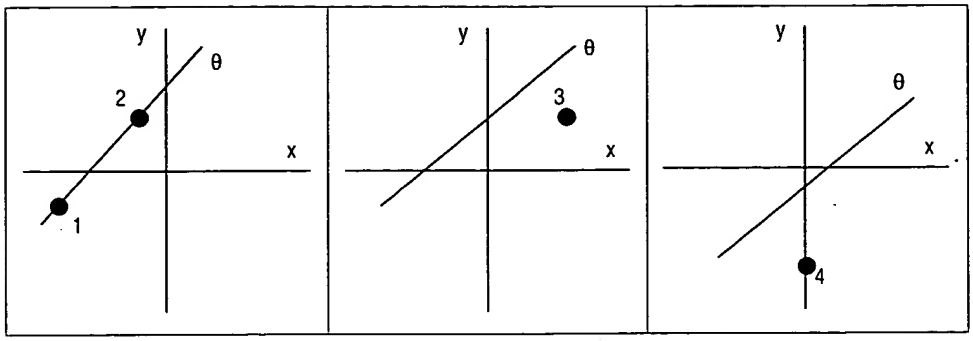


Figure 19: The Recursive Linear Least Squares Method for Updating q with Each Additional (xi,yi) Data Point.

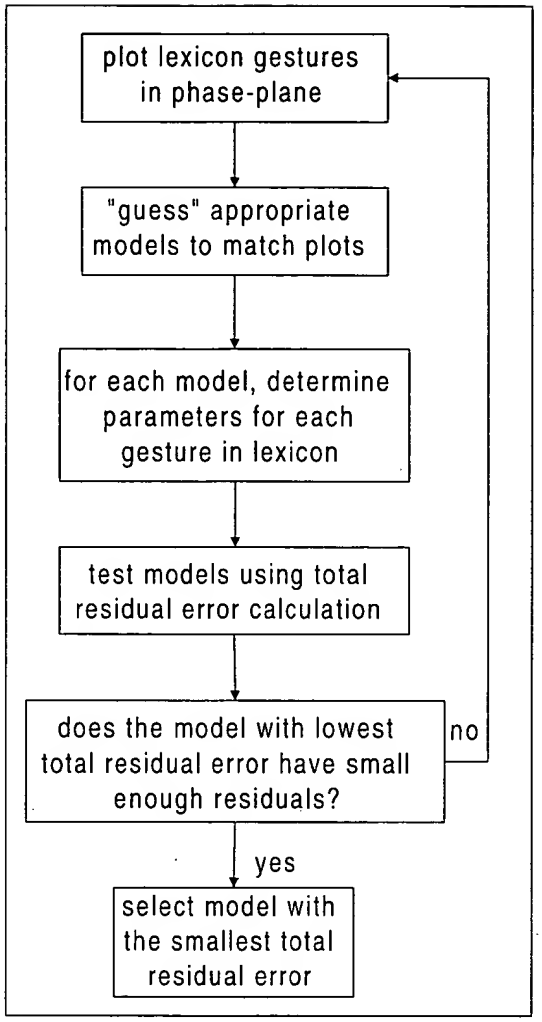


Figure 20: An Algorithm for Determining the Specific Gesture Model.

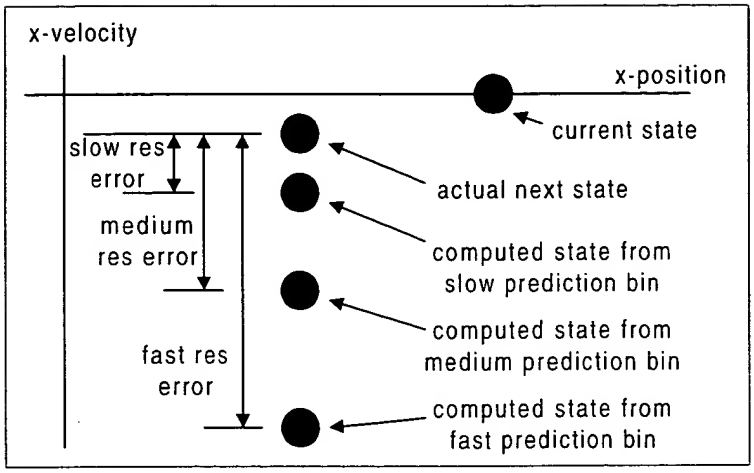


Figure 21: An Exaggerated Representation of the Residual Error Measurement.

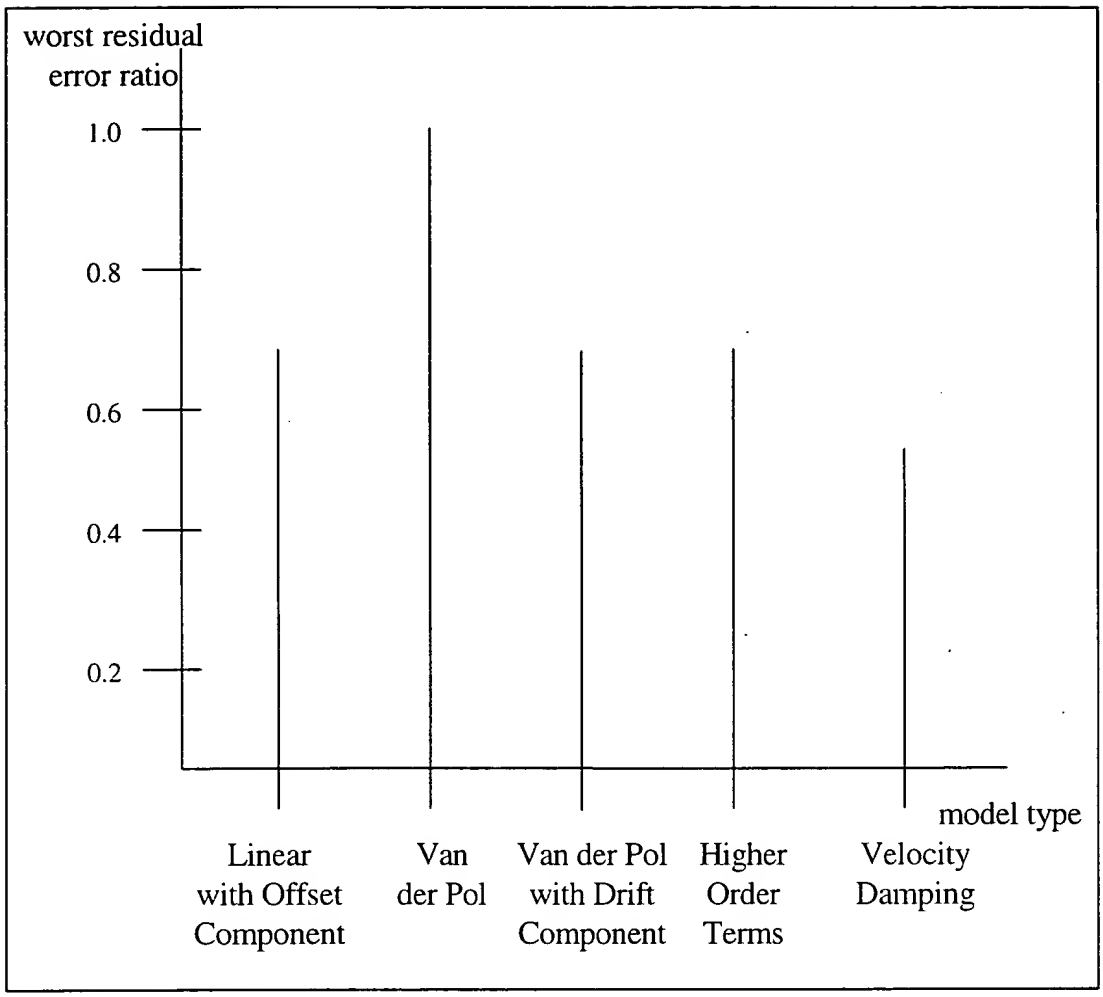


Figure 22: The Worst Case Residual Ratios for Each Gesture Model. The Lower the Ratio, the Better the Model.

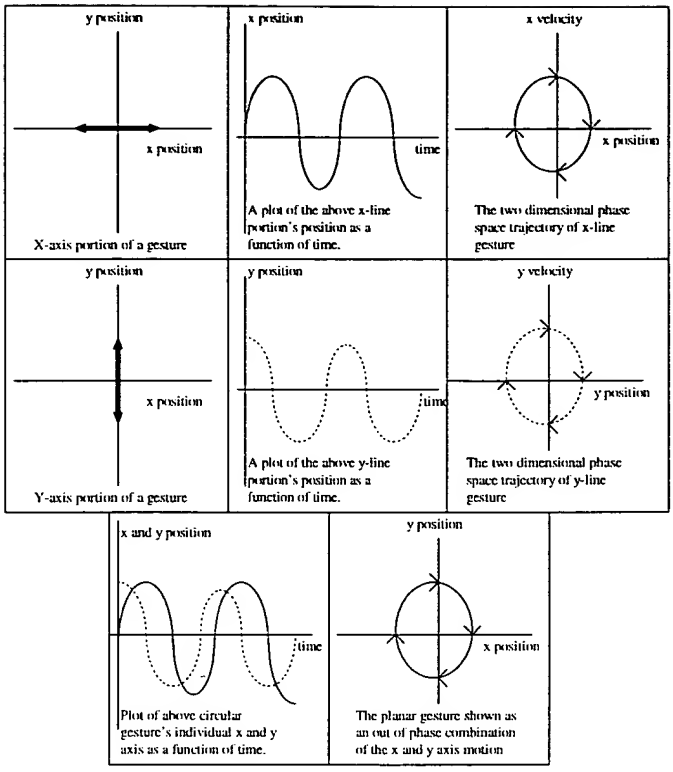


Figure 23: Two Perpendicular Oscillatory Line Motions Combined into a Circular Gesture.

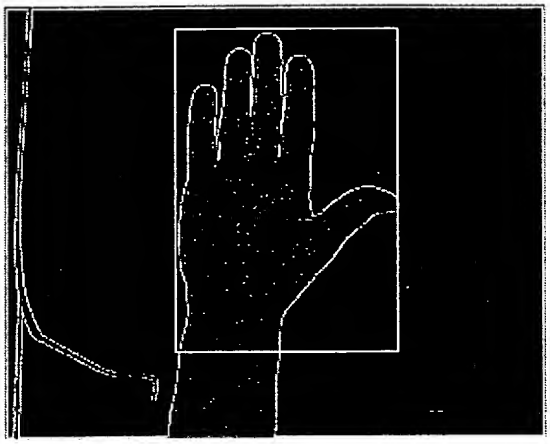


Figure 24: Bounding Box Around Hand.

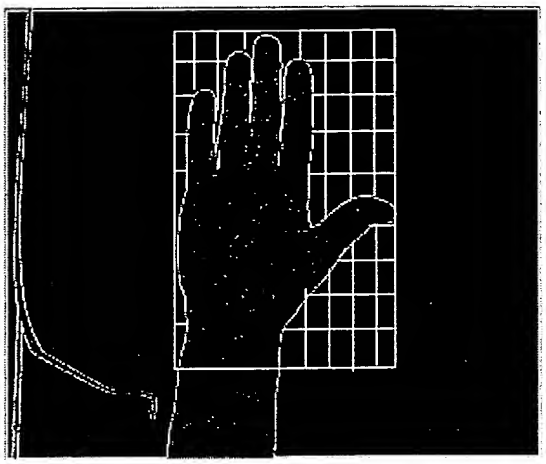


Figure 25: Descriptions from Bounding Box.

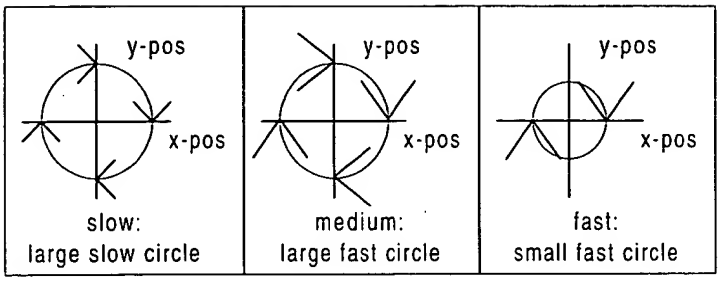


Figure 26: The Example Gestures.

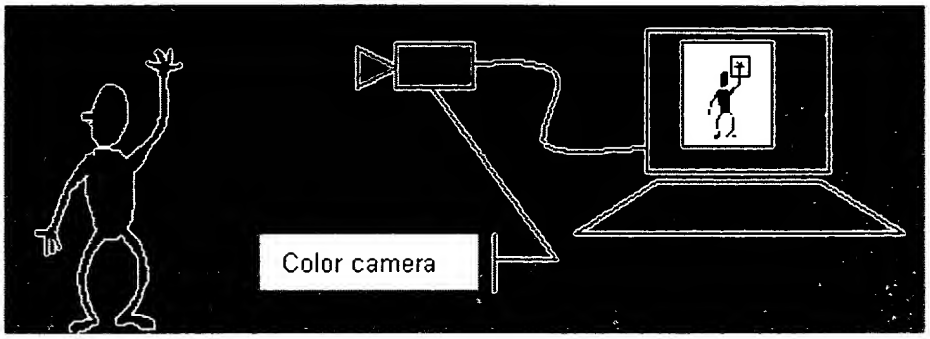


Figure 27: Schematic of the Hand Tracking System Hardware.

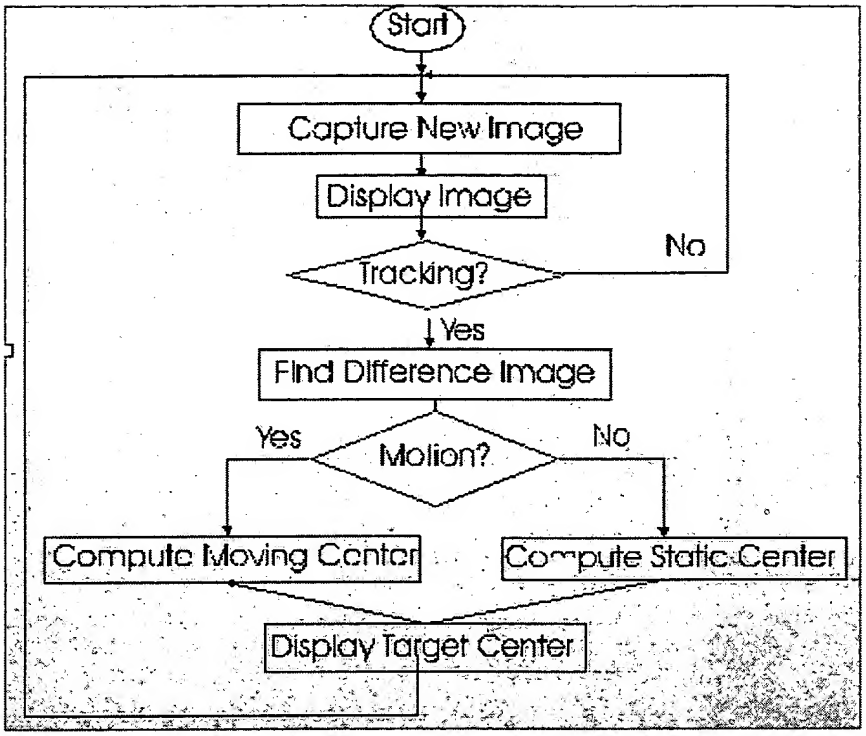


Figure 28: Flowchart of the CTS.

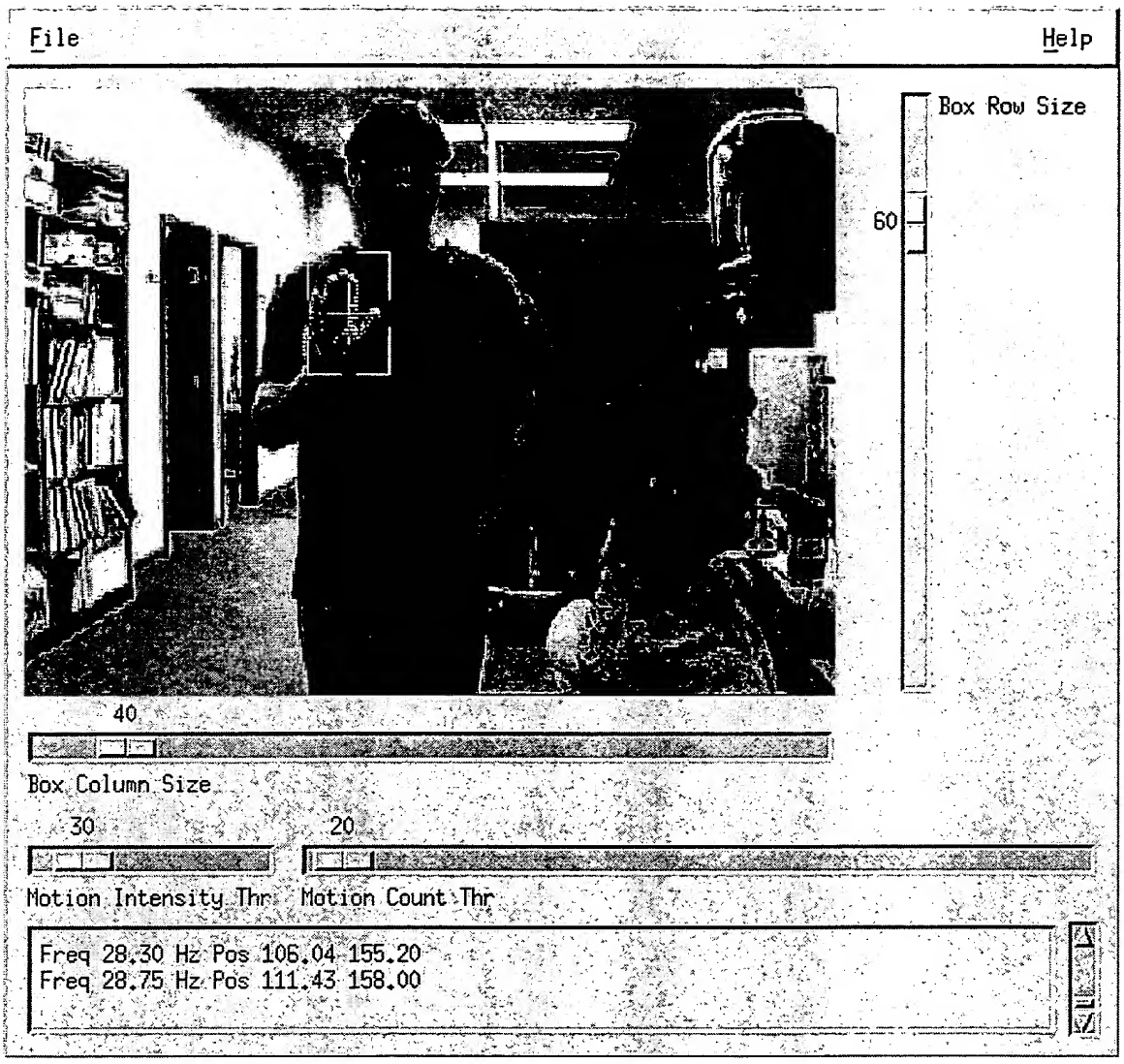


Figure 29: Graphical User Interface of the CTS.

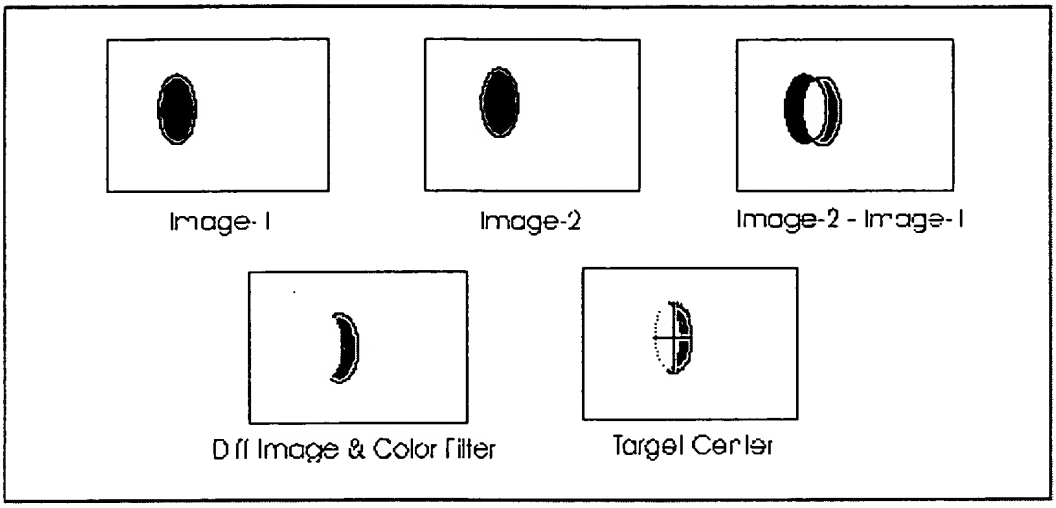


Figure 30: Target Center from Difference Image.

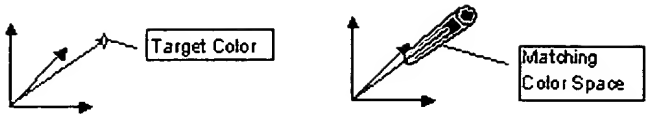


Figure 31: Color Matching Technique.

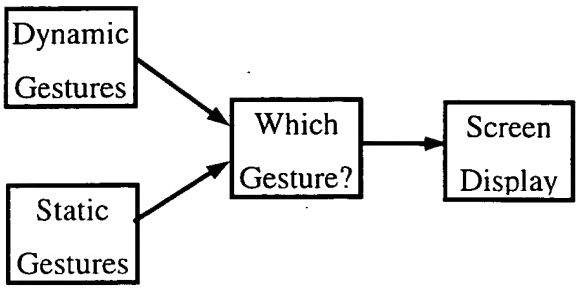


Figure 32: Identification Module.

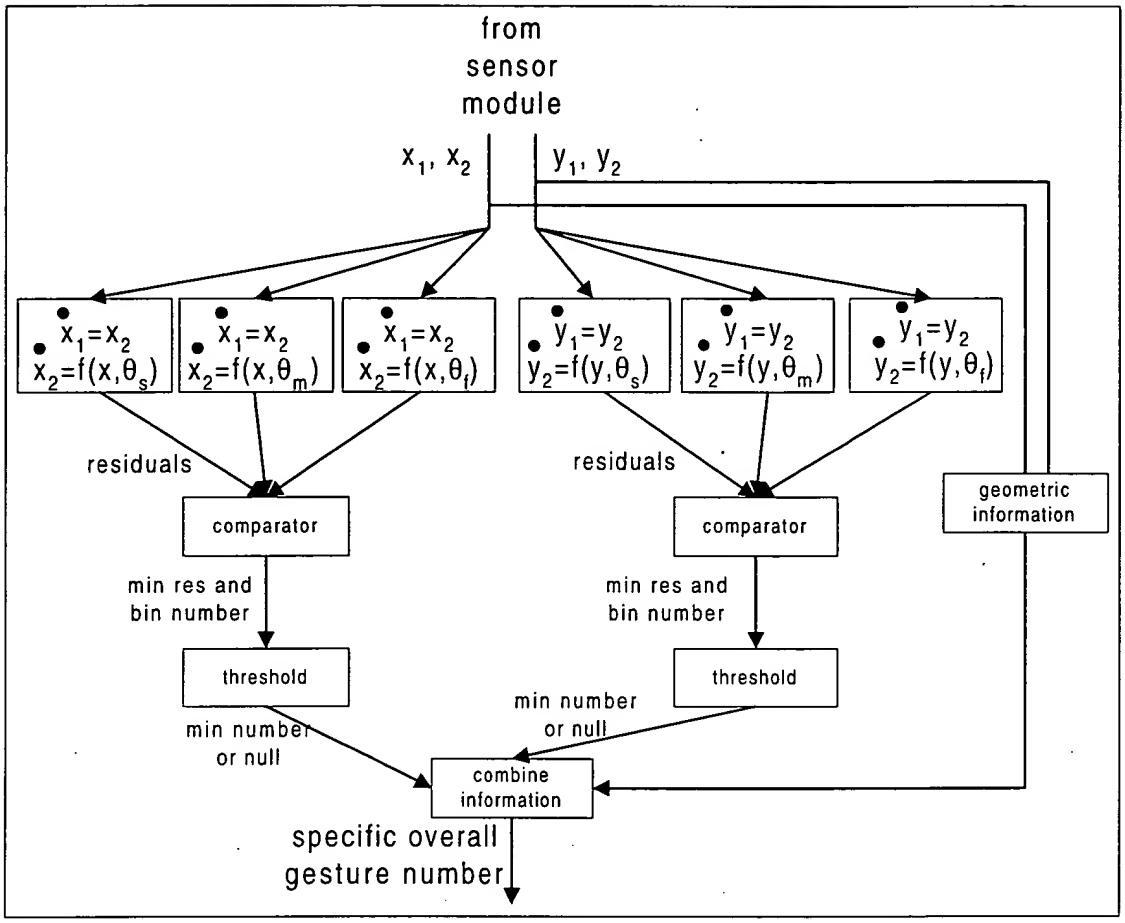


Figure 33: Simplified Diagram of the Dynamic Gesture Prediction Module.

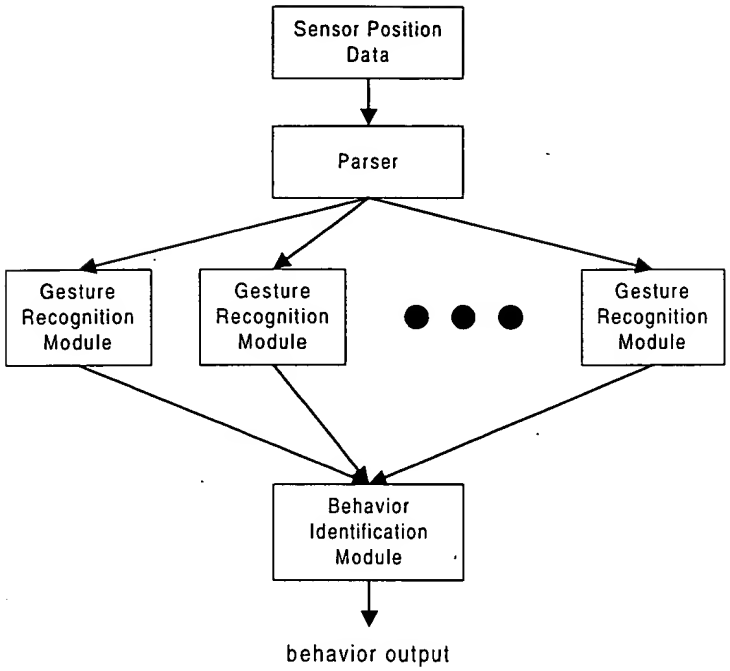


Figure 34: Behavior Recognition Module.